

Governor's Higher Education Summit

January 24, 2003

Executive Summary

As preparation for a Higher Education Summit meeting in fall 2002, Governor Mark Warner created and appointed members to the Steering Committee on Research Capabilities and Centers of Excellence. The steering committee's charge was to prepare information and recommendations about the state of the research enterprise in Virginia institutions of higher education. Governor Warner appointed Dr. Charles Steger, president of Virginia Tech, to chair the committee and also appointed the following members:

Steering Committee Members

Mr. W. Heywood Fralin, Chief Executive Officer, Medical Facilities of America, Inc.

Dr. James G. Lollar, Associate Professor of Management & Marketing, Radford University

The Honorable George C. Newstrom, Secretary of Technology, Richmond

Mr. Robert J. "Bob" Stolle, Executive Director, Greater Richmond Technology Center

Dr. Lydia W. Thomas, President and CEO, Mitretek Systems

The Honorable Jane H. Woods, Secretary of Health and Human Resources, Richmond

Resource and Staff

Dr. Gene Block, Vice President and Provost, University of Virginia

Dr. Gillian Cell, Provost and Vice President for Academic Affairs, College of William and Mary

Ms. Judy Heiman, Senior Higher Education Analyst, Department of Planning and Budget

Others

The Honorable Belle S. Wheelan, Secretary of Education, Richmond

Mr. Peter A. Blake, Deputy Secretary of Education, Richmond

The committee began its analysis with the State Council of Higher Education for Virginia (SCHEV) report, *Condition of Research at Virginia Colleges and Universities*.¹ The analysis focused on specific recommendations that could be implemented in the commonwealth to address a challenge goal outlined by the Governor in his 2002 State of the Commonwealth address:

I have also directed the Secretary of Education to work with me in convening a Higher Education Summit. Our goal will be to make Virginia's colleges and universities leaders in the arts, the sciences, and in technology. The summit will do three things: find ways to make Virginia's colleges and universities more entrepreneurial; to identify ways to reduce bureaucratic oversight; and to strengthen our research capabilities. By the end of the decade, our goal is to have at least 15 additional Virginia research programs ranked in the top five nationally.

The committee concludes that it will be necessary to make significant changes in the way the Commonwealth deals with the university community, to make significant investments, and to re-evaluate the policies that are applied across our higher education institutions. Even with major investments and structural changes, the university system will face a real challenge to progress from its current status to the lofty position articulated by the Governor.

The committee makes the following specific recommendations:

1. Commission an outside panel of experts to evaluate the excellence of selected programs, identify the weaknesses that can be addressed with strategic investments, and provide a baseline for decisions about the structure, funding, and impacts of the Commonwealth's research universities.
2. Develop a systematic and strategic investment strategy to bolster the excellence of research programs. Use a greatly expanded and focused CTRF-like program that encourages teaming among colleges and universities and interactions with business and industry. Investments in the order of \$100 million per biennium will be required to make substantial progress.

3. Articulate the value of university research on the economic well-being of the Commonwealth. This requires recognizing the importance of high quality faculty, students, and staff to the vitality of research opportunities in the Commonwealth, and structuring budgets and programs to attract and retain the “best and brightest.” Also, the Commonwealth should establish matching endowments to support chairs, professorships, and programs (i.e., centers).
4. Capitalize on the proximity of federal agencies to Virginia educational institutions to enhance the funding base and build economic development opportunities.
5. Build partnerships with industry for economic development and access to a broader funding base for research. Evaluate policies and laws pertaining to intellectual property to enhance opportunities for public/private enterprises.
6. Examine the effectiveness of advocacy of higher education in Virginia compared to other successful states and plan a restructured approach to increase federal awards for academic research. Appropriate coordination of federal agency advocacy and strategic collaboration among our universities and with relevant statewide groups can be instrumental in achieving this goal.
7. Categorize the higher educational institutions within the state and develop differential investment strategies based on each institution’s role. Establish the pipeline from excellent undergraduate programs to provide the students for graduate programs, and ultimately faculty, for our higher education system.
8. Initiate a Commonwealth-wide graduate education stipend program for graduate research assistants (GRAs) and tuition scholarships for graduate students being trained in areas impacting economic development. Overall, this action will have a positive effect on economic development by permitting faculty researchers to more effectively address research problems that will lead to new economic development opportunities.
9. Re-evaluate the state fiscal policies regarding support to the research activities of the universities. These include using earned overhead from research as an offset for Education and General Appropriations, expanding the equipment trust fund to support research equipment, establishing a systematic mechanism to address renovation of research space to keep it modern and responsive to needs, and revisiting the policy on capital construction of educational vs. research buildings and infrastructure.

1.0 Overview of Research Activity in Virginia’s Colleges and Universities

In May 2002, the State Council of Higher Education for Virginia (SCHEV) released a report, *Condition of Research at Virginia Colleges and Universities*.² The purpose of this report was “1) to outline past policies and identify prominent issues; 2) to raise questions about the current status of academic research in Virginia; and 3) to document eight key findings that ought to factor into the planning and implementation of future activities undertaken by the Commonwealth.”

The report made the following observations about the research activities within the Commonwealth’s colleges and universities:

In looking only at academic R&D, Virginia ranked 16th nationally in 2000, based on total R&D expenditures. This ranking has been fairly consistent over the last 10 years. The competition for funding of academic research, however, is increasingly fierce. In 2000, the top four states accounted for 33 percent of the total academic R&D expenditures nationwide. The top 15 states accounted for almost 70 percent of the total expenditures. The facts provide a mixed message on the Commonwealth’s research activity. Although Virginia ranks among the top third of states in this area, much of the research activity is occurring in the higher ranked states. Furthermore, adjusting for the state’s size and economic productivity, Virginia does not fare well at all. Looking at academic R&D expenditures per capita, Virginia ranked 37th nationally in 2000. Comparing academic R&D expenditures as a percentage of gross state product, Virginia drops even further – ranking 39th in that same year.

Turning from aggregate state-level expenditures and rankings to individual institutions’ expenditures and rankings, a similar picture emerges. Based on total R&D expenditures at doctoral-granting institutions, none of Virginia’s public or private colleges and universities currently ranks in the top 50 nationally. Virginia Tech and the University of Virginia fall just short – ranking 51st and 58th respectively in 2000. No other Virginia institution is ranked among the top 100 institutions. Although the rankings in and of themselves do not necessarily indicate the success of an institution’s research program, they do allow for important comparisons. In looking at the expenditures of those top-tier institutions, it is clear that the most prominent research institutions account for the lion’s share of the R&D activity in the nation. Of the 589 institutions tracked by the National Science Foundation, the top 40 accounted for over 50 percent of total academic R&D expenditures nationwide in 2000. If Virginia’s institutions want to improve their rankings, significant investments – from both the public and private sectors – will need to be made.

The SCHEV report made eight key findings:

Finding 1: The ability of research universities to attract federal support for R&D activities is driven largely by their ability to align faculty expertise with the federal research agenda.

Finding 2: Despite the Commonwealth's efforts to attract and retain top-notch faculty, Virginia institutions still appear to lag behind the top national research universities in terms of world-renowned researchers.

Finding 3: Although many of Virginia's graduate research programs are nationally recognized, few science and engineering programs are ranked among the top-tier programs in the country. Without top-notch programs, Virginia will face increasing difficulty in attracting and developing world-class researchers in these, and related, fields.

Finding 4: Virginia's colleges and universities face a serious shortfall in the amount of research space available to support their *existing* research programs.

Although the projects contained in the 2002 GOB referendum, if approved by voters, will help address this issue, Virginia's research universities will still face a research space deficit between 325,000 and 350,000 assignable square feet.

Finding 5: Virginia's ability to conduct state-of-the art research and its ability to attract world-class faculty is dependent, in part, on the availability and sophistication of its research equipment. For 15 years, the Higher Education Equipment Trust Fund (HEETF) has provided a predictable stream of funding to address this and other institutional technology issues. With budget reductions for the HEETF program now a reality, Virginia's institutions will lose ground.

Finding 6: Virginia's faculty are not generating as much research support as their peers nationally, based on research expenditures per full-time faculty.

Finding 7: The lack of state policies that support and foster academic research has hindered the ability of Virginia institutions to advance their research efforts.

In support of undergraduate education, the Commonwealth has adopted numerous policies over the last decade that have intentionally or unintentionally placed a higher priority on teaching and learning as opposed to research. Those policies impacting Virginia's colleges and university research activities include:

- increasing faculty-teaching loads, resulting in less dedicated time for research;
- providing greater access to undergraduate education through tuition restraints and increased undergraduate financial aid, while graduate tuition rates escalate and state support for graduate financial aid stagnates. This focus appears to have limited opportunities for the Commonwealth to have invested in graduate education;
- increasing administrative efficiencies through restructuring and decentralization efforts, inhibiting long-term investments, which has inhibited long-term investments in research;
- identifying adequate funding for instruction and academic support through the creation of a base adequacy funding formula that stops short of addressing funding needs for research, but which does not address institutions' research needs or funding for medical education or research needs for libraries;
- investing in the new construction and renovation of academic space and instructional technology, with only minimal investments in research facilities; and
- ensuring that institutions maximize the use of non-state resources to support the administrative functions associated with research, leaving institutions with less resources to re-invest in research activities.

Finding 8: Most successful state R&D initiatives share key similar characteristics: 1) focused area(s) of research; 2) long-term and sustained investments in research activities; and 3) collaborative efforts among higher education, government, and business and industry.

This background serves as the starting point for this report from the Committee on Research that is intended to provide a basis for discussion at the Governor's Higher Education Summit.

2.0 Problem Description as Defined by the Committee

2.1 Value of Scholarly Inquiry to the Educational Process

The role of research universities is to pass the torch of knowledge to the students through leadership and scholarship in the academic community; to the education community through publications and the next generation of teachers; and to the public through outreach in many forms — service, consulting, intellectual properties, continuing education, etc. New technologies and economic development depend upon new basic knowledge, which comes as a result of having the resources and time to ask questions, and knowing which questions to ask and which paths to follow. Research without scholarship is a job only half done. Scholarship is a part of the academic process that can provide the insight and resources to take basic knowledge to the next steps — whether it is more questions, development into applications or creative enterprises, or sharing and broadening perceptions.

The most frequently used yardstick for gauging research status is the National Science Foundation (NSF) report of research expenditures. Although the measure is of research expenditures, which includes sponsored research, earned overhead, institutional investment, and other investments in research, it reflects strengths in academics and students. Good research programs need good graduate students and attract good students. Recent surveys of graduate students identified program quality, including a match with research interests, amount of support, and marketability of degree as the top three reasons for accepting an offer to attend a specific research university. Students are attracted by good academic programs that will provide life-long credentials, research that is pushing the envelope of disciplinary boundaries and making a difference, faculty members who are interested in the future and success of their students, and institutions that show their commitment to graduate education by providing student support. It is a case of reaping what we sow.

Everyone owns the results of university research, but research is a process that requires steady, reliable, nourishing support. It is part of the education package. Research universities themselves support the offerings of all colleges and universities, as well as K-12 education and business. With tighter budgets and continuing debates over whose programs are most critical, the need for research universities to justify themselves is not going to go away.

The focus of this committee report is research, but research is inextricably tied to scholarship and education, which is what the Commonwealth's colleges and universities are about. Research, in its broadest context, applies to all disciplines across the higher education system. The committee focused on the sciences because these disciplines are the ones where significant grant and contract funding is available, and where opportunities for economic development and industry partnerships lie. However, on a higher plain, research universities address the issues and problems society faces and conduct the basic research and scholarly inquiry that is the foundation of discovery. Discovery in the arts, humanities, sciences, and technology takes time, intellectual elbow room, and resources. Faculty scholars in all fields ask questions, seek answers, and ask the next round of questions. A vibrant system of higher education in Virginia must be excellent in all scholarly arenas to serve, adequately and appropriately, our citizens and their expectations for the highest quality of life.

2.2 Focus of Committee — Funded Research and Economic Development

The relationship between funded research and economic development is fairly well documented. In fact, one recent report³ attempted to quantify the impact that research universities have on economies, specifically the role of MIT-related companies to the U.S. economy. The authors assert that graduates of MIT have founded approximately 4,000 active companies, a quarter of which are headquartered in Massachusetts. These companies employ approximately 125,000 people or 5 percent of total state employment.

They also remind the reader that while only 8.7 percent of MIT undergraduates grew up in the state, many of their “company founder” graduates remain in the state. It is also interesting to note that in another survey, Massachusetts-based companies ranked access to MIT and to other universities ahead of low business cost.

A study published by the US Department of Commerce, Economic Development Administration,⁴ noted that major universities and research institutions are a key component of the model linking economic development to research and development activity. While the document addresses other sectors, the university research component is identified as one of the suppliers of innovation that share responsibility for the outcomes of economic development actions.

Berglund and Clarke (2000)⁵ refer to universities as a “state’s intellectual infrastructure.” Data from another study included in their report show that in the top 30 high technology metropolitan areas, 29 were either home to or very near a major research university. North Carolina’s Research Triangle Park is one of the earliest examples of a state utilizing its R&D assets to further economic development. Today, there are more than 100 R&D facilities in the park, employing more than 37,000 people with combined annual salaries of more than \$1.2 billion. The occupants of the park take advantage of their proximity to Duke, North Carolina State University, and the University of North Carolina-Chapel Hill.

The authors of *Benchmarking Economic Transformation in the Nation's Metropolitan Areas*⁶ also provide evidence for the importance of research and development to economic growth. They found that metropolitan areas that have academic institutions performing large amounts of R&D, particularly R&D funded by industry, are more able to attract and grow technology companies.

The information presented above, while limited, leads one to the conclusion that wherever there is a strong research base, economic development will surely follow. But as we all know, nothing is ever that simple. A recent case study of Johns Hopkins University⁷ demonstrates that the presence of a very highly ranked research institution with significant funding is not sufficient (Feldman and Desrochers, 2002). The authors explore the institutional context of universities including the mission, patent and ownership of intellectual property policies, funding sources, prior institutional experiences, degree of risk aversion, and commitment to change. Johns Hopkins has not generated highly visible economic benefit for the local area. The authors conclude that the primary reason for the lack of development despite what should be an economic engine for the area is that economic development was never one of the university's objectives. As a result, there was a lack of incentives and encouragement for commercial activity that might have benefited the area.

The committee discussed all of these topics and while it recognized that the issues noted in the study of Johns Hopkins are, in some instances, issues for Virginia's institutions and must be dealt with, the committee would concentrate its efforts on ways to increase funding for research. Without adequate funding as the necessary prerequisite, it will not be possible for Virginia's research universities to attract new businesses or provide existing businesses with the "intellectual infrastructure" required for future economic development.

3.0 The Landscape of the Competitive Environment in Research

3.1 International Landscape in Research

Internationally, the U.S. faces tough competition,^{8,9} mostly from European and Asian countries that have come to the realization that future leadership will depend on technological capabilities in a variety of sectors. Thus, the competition is investing strategically in research and development on several fronts. In 1998, Japan was on its way to doubling its genomics research. Japan has also made a leap forward in computational sciences with their "Earth Simulator" teraflop computer. Korea and China have been investing heavily on research training. Germany, Scandinavia, and Switzerland are poised to be leaders in structural biology, as is the United Kingdom. More specifically in Germany, the Max Planck Institute is a molecular biology giant.

The revolution in the life sciences is likely to continue to expand at an accelerated pace. Biomedical discoveries and commercial opportunities will multiply during the next decade as a result of the technological development not only in biology and medicine but also in other areas, including nanotechnology, high-throughput drug screening, robotics and/or automated processing of molecules, chemical synthesis of biological compounds, and bioinformatics.

At the core of this revolution is genomics and its derivations (the so-called post-genomics era), which is allowing us to imagine and build designer molecules applicable to human and animal health, crop production, cosmetics, and other industries. Companies around the world are restructuring, reinventing themselves in a way that will change the world's economy. Monsanto, Novartis, Dupont, and Hoechst are switching from the production of chemicals to the new economic sector, the life sciences.

Biotech, chemical, pharmaceutical, and agribusiness companies are investing in molecular technologies. These companies are forming strategic alliances to link their industries with those in other fields: agriculture, bio-medicine, drug development, and bioinformatics/genomic information. It seems that the objective will be to be outstanding in several areas simultaneously: chemicals, food production, medicines, vaccines (which can be engineered to be consumed with our food), robotic processing, tissue engineering, and bioinformatics.

The Commonwealth must also seize the initiative in nurturing areas of research that have strategic national implications. NASA Langley Research Center is the nation's acknowledged civilian aeronautical research leader, but the U.S. is losing its competitive advantage in the commercial aircraft market. Virginia universities can play a major role in evolving future aircraft systems while becoming the recognized center for research excellence. Similarly, the Thomas Jefferson National Accelerator Facility offers the Commonwealth's universities the opportunity to pursue research in fundamental particle physics where new kinds of sensors and computational systems can be employed in pursuit of basic physics but also leading to new advances in sensors, devices and laser processing methods. Marine science is likewise important for our coastal areas. Modeling and simulation and computational science have also been responsible for significant industrial development. These fields are key in the elaboration of homeland security and transportation systems and design.

These conglomerates will require the partnership of government, universities, and industry, offering new opportunities for the Commonwealth. Access to and control of information and knowledge will be as important as developing products. New challenges

will ensue. Regulatory agencies will have to deal with products that are at the boundaries of disciplines, such as cosmetics that deliver medications, vaccines, or anti-aging compounds. The progress in stem cell biology, food distribution, pharm-animals, and tissue engineering will require a concerted effort by our society to deal with the ethical and legal issues ensuing from the transformation of our society.

The Commonwealth has expertise in several areas mentioned above and can position itself to take advantage of these opportunities by investing resources strategically and developing consortia among our leading universities, government, and the industrial sector.

3.2 Statewide Landscape

The Commonwealth enjoys several competitive grant programs open only to Virginia universities. The nascent Commonwealth Technology Research Fund (CTRF), which is in its inaugural three-year cycle, is providing Virginia universities with access to peer-reviewed state funding focusing on specific technology opportunities. The program supports collaborations between industry and state universities, and helps leverage federal resources. An example of a successful partnership launched by CTRF funding is the three-year research initiative in cancer genomics between VCU, George Mason University, and Inova Health System. While the state has committed to funding the first three years of projects, there is no new funding designated in future budgets.

The Virginia Life Sciences Initiative proposes to jointly establish four new multi-disciplinary research centers of excellence at four of the five Virginia research universities. This long-term commitment between the state and the universities creates a partnership for academic excellence and economic development. The focus of the initiative will be on “new biology” and details of the program are still being developed. Old Dominion University does not have one of these Virginia Life Science Initiative Centers.

Virginia universities also receive many small competitive grants and matching funds from the state’s Center for Innovative Technology (CIT). CIT plays a significant role in promoting Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. Future funding levels for CIT programs are uncertain.

Headquartered in Roanoke, the Carilion Biomedical Institute (CBI) is a joint partnership of the Carilion Health System, the University of Virginia, and Virginia Tech. Its mission is to strengthen biomedical research at its partner institutions and to promote economic development in the region.

One of the most important components in attracting and retaining outstanding research faculty and graduate students is the availability of and access to the latest and best scientific equipment. The state realized the value in funding assistance for equipment with the creation of the Higher Education Equipment Trust Fund over 15 years ago. However, the budget for this program will be cut by almost 30 percent in the next fiscal year, creating a loss of millions of dollars for Virginia universities.

As the SCHEV Report highlights, state universities cannot conduct research without adequate equipment and space. Virginia public universities face a critical shortfall in research space for existing programs. About half of the shortfall of needed research space will be addressed by the 2002 General Obligation Bond referendum. Research programs can be effective only if suitable facilities are available.

3.3 National Landscape

As described in the SCHEV Report, other states are targeting millions of dollars in support of research programs in life sciences, nanotechnology, information technology, and bio-terrorism, with the goals of fostering economic development, inter-university collaborations, industrial partnerships, and leveraging of federal funds. Michigan, North Carolina, California, New York, Pennsylvania, and Ohio are all aggressively funding research collaborations among industry and their universities. Without significant state investment in research, Virginia universities are at a competitive disadvantage with peer institutions from other states.

At the federal funding level, the National Institutes of Health (NIH), the National Science Foundation (NSF), the National Aeronautic and Space Administration (NASA), and the Departments of Defense, Education, and Agriculture are the main federal government sponsors of research at Virginia universities. The NIH and NSF have committed to sustained predictable growth in their extramural funding programs over the next several years. NIH will have achieved a doubling of their research budget based on the currently proposed FY 2003 budget. NSF is also launching an initiative to double their budget over the next several years. Furthermore, the Department of Defense, and now the proposed Department of Homeland Security, has seen increases in funding opportunities in connection with the fight against terrorism. Virginia universities are reasonably well aligned to compete aggressively in these areas. Federal agencies frequently require matching components from institutional or state sources in awarding their grants — the larger the award, the greater the amount of the required match. The CTRF was designed in part to address this need, but with the cessation of CTRF funding and the absence of other state resources, Virginia institutions are placed at a decided competitive disadvantage in seeking large federal awards. Other states are pursuing these opportunities with great zeal, and it will be difficult to surpass them without additional commitment from state resources.

4.0 Relative Competitive Position of Programs in Virginia's Colleges and Universities

4.1 The 2010 Goal

Governor Mark Warner has outlined a goal for Virginia's higher education institutions that by 2010 there should be 15 academic programs that rank in the top five nationally. This is a true challenge goal that will require some rethinking, redirection of resources, and general increases in resources. In states where top-ranked academic programs are found, there are policies in place that note the distinction between the major research universities and the other academic institutions. The University of California system, for example, is designated to be the major research universities in the state, while the California State system is tasked with the major undergraduate teaching responsibilities. These distinctions are recognized in the funding differentials associated with these distinctly different missions.

It can be readily demonstrated that excellent academic programs accompany strong research activities. Further, top-ranked programs at public universities are usually accompanied by large private endowments as well. The figure below illustrates the correlation of National Research Council ranking of academic chemistry programs with overall NSF research expenditures ranking. Outstanding programs are seldom, if ever, found at the weaker research universities.

Sorting out and prioritizing the excellent academic programs across the Commonwealth's colleges and universities is going to be a critical step in meeting the Governor's challenge goal for the academy. This sorting will be a necessary step, but not a sufficient one. There will need to be some targeted investments to follow the sorting in order to advance the excellent programs to national status. There also needs to be a recognition that excellent programs are not born overnight. After investments are made, faculty recruited, and facilities and equipment provided, the programs will mature and gain the reputations that bring them to national prominence over a significant period of elapsed time. Investments to accomplish this must be substantial (i.e. \$100 million per biennium) and sustained.

4.2 How Close Are We?

The subject of national ranking of programs is complex. The most widely accepted ranking of academic programs is done by the National Research Council (NRC) every 10 years. The last ranking was done in 1993 and published in 1995; planning has commenced for a new study beginning in 2003. Other program rankings are done by a number of entities. One popular ranking is done annually by the *U.S. News & World Report*, but the methodology is qualitative, at best, and is not well accepted in the academic community. There are also rankings done by professional societies, and there are largely unsubstantiated claims to excellence in a variety of areas. The appendix contains several tables that summarize some published and qualitative information about program rankings.

Virginia Tech has six ranked programs, Old Dominion University has one program, and the University of Virginia has eight programs ranked in the top 30 in the last NRC study. There are no other NRC-ranked programs in the top 30 in the Commonwealth. In the top 10, Virginia Tech's Industrial Engineering Program is rated number eight (of 37), and the University of Virginia has three top 10

programs in Arts and Humanities (#5 in Spanish and Portuguese Language, #6 in Religion, and #4 in English Language and Literature). The graduate research programs at Old Dominion University's Center for Coastal Physical Oceanography (CCPO) were ranked #17 in the nation for overall effectiveness.

The *U.S. News & World Report* rankings includes programs at the University of Virginia, Virginia Commonwealth University, Virginia Military Institute, and Virginia Tech. In the 2002 rankings in science and engineering categories, Virginia Military ranks sixth in Civil Engineering for schools without the Ph.D. program, and Virginia Tech ranks fifth in Polymer Chemistry, eighth in Industrial and Systems Engineering, and ninth in Stratigraphy/ Sedimentology.

The real message is that there needs to be a rigorous and objective analysis and ranking of programs within Virginia's colleges and universities to provide a decision baseline for program development. Only with such a baseline will it be possible to truly assess the quality of programs. The methodology noted below is suggested as the means to establish the baseline status and to help develop a strategy to enhance the excellent programs within the state to meet the Governor's goal.

4.3 Determining our Competitive Position

In order to make a baseline determination of the status of programs within the Commonwealth, a two-step process is recommended. It is suggested that the first step in the process should be to commission the Virginia Research and Technology Advisory Commission (VRTAC) to make an analysis of the notable (ranked and unranked) programs identified in the section 8.0 appendix tables (along with others that may not be included). From this analysis, a list of the highest nationally ranked programs should be developed.

Next, a "Blue Ribbon Panel" made up of nationally recognized experts from the National Academy of Sciences and National Academy of Engineering (National Research Council as the convener) should be commissioned to examine the strengths and weaknesses of the Virginia research programs identified. This panel should be charged to do an "NRC-like" analysis and to compare with competitive programs that have been nationally ranked. The panel's views would be unbiased and should yield well-reasoned input that could be used to guide the strategy for investments.

The charge to the panel should be:

1. Assess the current status of the VRTAC-identified programs and rank them into categories (e.g. current top 10 programs, programs with potential for top 10 status with indications of the weaknesses that require correction, programs that may not have top 10 potential at any reasonable level of investment).
2. Based on the program rankings noted above, suggest a tiered alignment of Virginia institutions of higher education (at least two tiers, based on overall research breadth and depth of programs).
3. Note potential synergies among the programs across the Virginia institutions where alignments of programs could lead to quicker success in attracting research funding.

The outcomes from this analysis should be expected to include:

1. A blueprint for managing investment in our universities where the potential for broad institutional excellence is most likely.
2. Identification of specific research programs and research leaders in the state that are truly excellent and well-positioned to align with multiple federal research strategies because of depth and breadth of research capabilities and experience. Strong programs will likely be identified at the comprehensive research universities. The potential for aligning and partnering among these universities and with other Commonwealth universities and colleges could be identified.
3. Identification of weaknesses among the strong programs that could be overcome with strategic investments.
4. Identification of opportunities for the comprehensive research universities and other Ph.D. granting research institutions to partner and gain synergistic advantages to link with major federal initiatives.

The Commonwealth should use this input to structure a systematic investment strategy to build on the strengths, perhaps using a mechanism such as an enhanced Commonwealth Technology Research Fund to select investments and program development opportunities or direct CIT funding resources toward this goal. There should be some provision in the investment strategy to foster strong, effective collaborations/partnerships among all research enterprises of the Commonwealth.

It should be noted that assembling a competent team of outside experts to assess Virginia's research capabilities is not a trivial undertaking, and would require adequate funding, as highly skilled professionals cannot devote their time to such a project without compensation. In addition, unless the Commonwealth is serious about making additional, targeted investments in research, over and above the base adequacy formula that is severely under-funded at present, an outside review panel would amount to an exercise in futility.

Should the Commonwealth choose to embark on a carefully planned program of investment in research at selected institutions of higher education or partnerships among institutions, it will also be essential to require strict accountability for results. But it is critical to provide our university leaders the flexibility to lead their institutions consistent with their respective new missions emanating from the NRC review. (“Results” in this context does not necessarily mean marketable intellectual property or new products; however, it does mean that the accomplishments of the state-funded research programs must be assessed periodically). New discoveries in basic research can have lasting impact and should be given equal weight with new products or processes if they are the aim of the research program. In any case, research investment should not, over time, become simply line item operating funding. An evaluation based on the products of the research, including such factors as additional federal or private funding generated through the program, must be conducted on a regular basis. Currently, no mechanism exists within the Commonwealth to conduct such reviews, and this activity again would require additional funding if it is to be conducted in a rigorous and professional manner.

5.0 Federal Strategy

The SCHEV report provides interesting background information about the status of the research enterprise in Virginia’s institutions of higher education. The data¹⁰ used in that report is largely derived from National Science Foundation reports. The data for fiscal year 1999 show that, although Virginia ranks third in total federal obligations for research and development (with 7.7 percent of the total \$73.8 billion reported), the state is 18th in federal obligations to universities and colleges (with 1.7 percent of the \$14.8 billion reported). These data indicate that Virginia has the challenge of increasing its yield of federal funding for its institutions of higher education.

As the SCHEV report notes in Finding 1, “The ability of research universities to attract federal support for their R&D activities is largely driven by their ability to align faculty expertise with the federal research agenda.” The Commonwealth can improve the ability of our universities to address these mismatches as suggested in the points noted below.

5.1 Focus Investments

A major strategic move within Virginia should be driven from knowledge of the strengths, weaknesses, opportunities, and threats (the classic strategic planning SWOT analysis). The analysis described Section 4.3 would largely fulfill this need.

5.2 Capitalize on the Federal Funding and Facilities in Virginia

With a concentration of federal agencies in the state, it is incumbent on the universities to forge closer relationships to derive research funding from these mission agencies. Within Virginia (as noted in the NSF report for fiscal year 1999), 35 percent (or \$2.02 billion) is spent within federal agencies or within Federally Funded Research and Development Centers (FFRDC) operated on behalf of the agencies. Virginia is home to seven of the nation’s 36 FFRDCs; five being affiliated with the Department of Defense, and one each with the Department of Treasury and the Department of Energy. Better alignment with these entities should yield higher federal funding flow to the universities. The following qualitative observations can be made:

1. The strong Department of Defense presence provides likely target agencies for major alignment. But proximity to NIH, DOE, and NSF must also be exploited.
2. Investment in “outside the gate” facilities for university researchers adjacent to major federal agencies will enhance the relationships and satisfy an often-expressed need to have close proximity with the federal staff. Examples of such a need have been identified at Quantico and at the NASA Langley facility.

5.3 Build Partnerships with Industry

Using the same NSF data for fiscal year 1999, 59 percent of the federal research dollars in Virginia (\$3.4 billion) are expended in industrial contracts. Aligning university researchers with these contracts would be a significant potential source of federal funds into the universities. There is a need for investment to launch such partnerships that will produce a return over time but do not get started without resources. Partnerships offer an indirect route to federal funding and also provide mechanisms for the research universities to expand and extend their capabilities, as well as enhance the employment base of the Commonwealth.

Policies that permit ready exchange of information and interactions of faculty with industries are also important to these partnerships. Many successful research universities have developed a reputation for close partnerships with industry and as intellectual resources for innovative start-up companies (e.g. MIT in Boston and N.C. State, Duke, and UNC at Research Triangle Park). These successful institutions have adopted policies and procedures that foster these industrial partnerships. They also have learned to deal with the complex intellectual property and conflict of interest associated with university-industry partnerships. It must be recognized that resolution of IP issues are part of the negotiation process for industrial-sponsored research and developing the flexibility to handle these negotiations more efficiently should be examined. The success of some of these institutions is demonstrated in their rank near the top in patent awards at research universities as noted in the SCHEV report.

It is suggested that a study of the legal and policy environment supporting the research universities with the most successes be made and compared to the extant environment in Virginia. This might be a relevant task for VRTAC in collaboration with the NAS/NAE study team noted previously.

There also may be an opportunity to align state economic development activities and funding as an investment pool to be used to initiate and nurture industrial partnerships to attract federal funding.

5.4 Advocate for Virginia Higher Education to Federal Government

While precise data are not available, the vast majority, and probably more than 95 percent of all federal funding, is awarded through competitive peer review. While this system is not perfect, it is greatly to be preferred to a solely political process. Given the separation of powers and the nature of legislative bodies, however, there will always be funds awarded at the margin through Congressional initiatives. Invariably, research awarded through the Congressional process (sometimes termed “earmarks”) can be traced to individual members of Congress sitting on committees where they can exercise influence towards this end. Historically, Virginia’s Congressional delegation has not been well placed in this regard, and assisting the many defense-related activities in Virginia has understandably been the highest priority of the delegation.

A study of the approaches used by other university systems in federal advocacy should be undertaken by a committee of the chief research officers of Virginia’s universities. California, Illinois, and other states could be benchmarks that could be used to formulate a more coordinated and effective advocacy in Virginia.

In Virginia, several universities currently pursue some form and level of advocacy. Without coordinated efforts there is the potential for conflicts of objective and strategy, as well as duplication of effort. The preferences of the commonwealth’s delegation need to be considered in the definition of any coordination of approaches. The desired outcome from advocacy is enhanced federal funding of Virginia’s higher education community. **At the end of the day, however, Virginia’s ability to be competitive in the federal research arena depends on the quality of the faculty at research institutions, the institutions’ research infrastructure and equipment, and the availability of state matching funding to support ambitious grant proposals.** Absent these essential elements for successful research, the Commonwealth can expect no remarkable increases in federal research funding to flow to our institutions of higher education.

With this background, there should be a goal for increased federal research support across the Commonwealth. The federal awards for academic research should be increased. Appropriate coordination of federal agency advocacy and strategic collaboration among our universities and with relevant statewide groups can be instrumental in achieving this goal. This can serve as a complement to existing university efforts.

6.0 State Strategy

According to the General Assembly Joint Subcommittee on Higher Education Funding, Virginia higher education was underfunded by more than \$200 million at this time last year. This was based on a comparison of funding of institutions of higher education nationwide. Since that analysis was completed, additional millions in General Fund support have been removed from the system of higher education through the budget cuts. While this has been partially recovered through tuition increases, it is clear that by any measure, Virginia higher education is suffering from a lack of funding. Moreover, given that research has only rarely and erratically been recognized as a priority by either the Executive or Legislative branch in Virginia, it is not surprising that Virginia’s ranking in university-based research is not impressive.

The situation is even more unfavorable in comparison with other states wherein, as is noted in the SCHEV report,¹ these states target additional funds to research – the Georgia lottery for the Georgia Research Alliance, Michigan Tobacco Settlement Funds, etc. What opportunities for major new investments for research exist in Virginia?

Excellent research programs require the combination of several elements:

- A motivated faculty
- Research facilities, libraries, and equipment
- Excellent graduate students

6.1 Categorize the Institutions of Higher Education in Virginia for Investment

An outcome of the outside review panel described in section 4.3 will be the rationale to align and differentiate the Virginia higher education institutions based on their strengths. With this information, the Commonwealth will need to make decisions about the

investments that will be needed to fulfill each institution's redefined mission. The linkages between the institutions will need to be formally described so that undergraduates feed into the graduate degree programs across the system.

6.2 Develop Mechanisms to Foster Faculty and Graduate Student Retention

Excellent research universities have a steady influx of excellent students and faculty. Budgets need to accommodate meaningful and consistent support for cost matching for endowments to support chairs, professorships, and programs. Graduate student support and tuition stipends need to be re-examined in the higher education appropriations process.

The Commonwealth should support stipends for graduate research assistants (GRAs) and tuition scholarships for graduate students being trained in areas impacting economic development.

In the highly competitive economy emerging, there is a compelling need for advanced students trained in areas related to economic growth potential in the Commonwealth. These areas include agricultural, scientific, engineering, and technology as well business and human resource development. By working closely with the faculty as graduate research assistants on R&D aligned with science, technology, and business development issues, many of these students will become critical employees in Virginia's businesses and industry. Furthermore, this program will focus the faculty's research programs toward areas relevant to the Commonwealth's needs.

This support for researchers will enable our faculty to be more productive and, as a consequence, more successful in the competition for grants and contracts, thus increasing the research dollars coming into the universities directly benefiting economic development. Overall, this action will have a positive effect on economic development by permitting faculty researchers to more effectively address research problems that will lead to new economic development opportunities.

6.3 Re-examine Commonwealth Fiscal Policies Related to Research Support

It is important to understand what barriers to building research programs exist in Virginia. One example involves indirect costs generated by research activities. Virginia institutions return 30 percent of their earned overhead from research expenditures to Education and General Appropriations to higher education instead of retaining them for research stimulation. The equipment trust fund is primarily targeted to educational equipment. Maintenance and renovations of research space are not systematically provided to keep research space modern and responsive to changing research needs. The state policy for supporting construction of research buildings that requires 50 percent of funding be raised from non-state sources needs to be re-evaluated. What are the impacts of these policies on research development and what messages are these policies sending? Any informed supporter of higher education recognizes the negative effect these have on research stimulation.

Many of the barriers have been instituted over time, and have been driven by budget constraints and other considerations. A change in the popular perception of the importance of research universities to the economy of the Commonwealth needs to be articulated. The return on investment for the state's resources needs to be quantified and clearly presented to the Legislature and the people of Virginia.

7.0 Summary and Recommendations

As outlined in the information above, there are several recommended actions that could be taken to enhance the capabilities of the academic research establishment within Virginia and to meet the challenging goal that the Governor has articulated. These recommendations are summarized as follows:

1. Commission an outside panel of experts to evaluate the excellence of selected programs, identify the weaknesses that can be addressed with strategic investments, and provide a baseline for decisions about the structure, funding, and impacts of the Commonwealth's research universities.
2. Develop a systematic and strategic investment strategy to bolster the excellence of research programs. Use a greatly expanded and focused CTRF-like program that encourages teaming among colleges and universities and interactions with business and industry. Investments in the order of \$100 million per biennium will be required to make substantial progress.
3. Articulate the value of university research on the economic well-being of the Commonwealth. This requires recognizing the importance of high quality faculty, students, and staff to the vitality of research opportunities in the Commonwealth, and structuring budgets and programs to attract and retain the "best and brightest." Also, the Commonwealth should establish matching endowments to support chairs, professorships, and programs (i.e. Centers).
4. Capitalize on the proximity of federal agencies to Virginia educational institutions to enhance the funding base and build economic development opportunities.
5. Build partnerships with industry for economic development and access to a broader funding base for research. Evaluate policies and laws pertaining to intellectual property to enhance opportunities for public/private enterprises.

6. Examine the effectiveness of advocacy of higher education in Virginia compared to other successful states and plan a restructured approach to increase federal awards for academic research. Appropriate coordination of federal agency advocacy and strategic collaboration among our universities and with relevant statewide groups can be instrumental in achieving this goal.
7. Categorize the higher educational institutions within the state and develop differential investment strategies based on each institution's role. Establish the pipeline from excellent undergraduate programs to provide the students for graduate programs, and ultimately faculty, for our higher education system.
8. Initiate a Commonwealth-wide graduate education stipend program for graduate research assistants (GRAs) and tuition scholarships for graduate students being trained in areas impacting economic development. Overall, this action will have a positive effect on economic development by permitting faculty researchers to more effectively address research problems that will lead to new economic development opportunities.
9. Re-evaluate the state fiscal policies regarding support to the research activities of the universities. These include the use of earned overhead from research as an offset for Education and General Appropriations, expanding the equipment trust fund to support research equipment, establishing a systematic mechanism to address renovation of research space to keep it modern and responsive to needs, and revisiting the policy on capital construction of educational vs. research buildings and infrastructure.